

Claims

1. An immunogenic composition comprising an isolated transferrin binding protein (Tbp) or antigenic fragment thereof and an isolated Hsf like protein or antigenic fragment thereof from the same or different Gram negative bacteria.
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2. The immunogenic composition of claim 1 in which the transferrin binding protein or fragment thereof and Hsf like protein or fragment thereof are from *Neisseria*.
- 10 3. The immunogenic composition of claims 1-2 in which the transferrin binding protein or fragment thereof is derived from *N. meningitidis*.
4. The immunogenic composition of claims 1-3 in which the Hsf like protein or fragment thereof is derived from *N. meningitidis*.
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5. The immunogenic composition of claims 1-4 in which the transferrin binding protein or fragment thereof is derived from *N. meningitidis* serogroup B.
- 20 6. The immunogenic composition of claims 1-5 in which the Hsf like protein or fragment thereof is derived from *N. meningitidis* serogroup B.
7. The immunogenic composition of claims 1-6 in which the transferrin binding protein or fragment thereof is derived from *N. gonorrhoeae*.
- 25 8. The immunogenic composition of claims 1-7 in which the Hsf like protein or antigenic fragment thereof is derived from *N. gonorrhoeae*.
9. The immunogenic composition of claim 1-8 in which the transferrin binding protein or antigenic fragment thereof is derived from *Moraxella catarrhalis*.
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10. The immunogenic composition of claim 1-9 in which the Hsf like protein or antigenic fragment thereof is derived from *Moraxella catarrhalis*.
11. The immunogenic composition of claim 1-10 in which the transferrin binding protein or antigenic fragment thereof is derived from *Haemophilus influenzae*.
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12. The immunogenic composition of claim 1-11 in which the Hsf like protein or antigenic fragment thereof is derived from *Haemophilus influenzae*.
- 40 13. The immunogenic composition of claims 1-12 in which the transferrin binding protein is TbpA or an antigenic fragment thereof.
14. The immunogenic composition of claim 13 comprising high molecular weight form TbpA or low molecular weight form TbpA or both high molecular weight form TbpA and low molecular weight form TbpA.
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15. The immunogenic composition of claims 1-14 in which the Hsf like protein is Hsf or an antigenic fragment thereof.

16. The immunogenic composition of claims 1-15 comprising antigenic fragments of Tbp and/or Hsf like protein capable of generating a protective response against Neisserial, *Moraxella catarrhalis* or *Haemophilus influenzae* infection.
- 5 17. The immunogenic composition of claim 16 comprising antigenic fragments of TbpA and/or Hsf.
18. The immunogenic composition of claims 1-17 comprising a fusion protein of Tbp and Hsf like protein or antigenic fragments thereof.
- 10 19. The immunogenic composition of claim 18 comprising a fusion protein comprising TbpA and Hsf or antigenic fragments thereof capable of generating a protective response against Neisserial infection.
- 15 20. An isolated immunogenic composition comprising an outer membrane vesicle preparation derived from Gram negative bacteria, in which expression of both transferrin binding protein and Hsf like protein are at least 1.5 fold higher than naturally occurring in the unmodified Gram negative bacteria.
- 20 21. The immunogenic composition of claim 20 in which the expression of transferrin binding protein is upregulated by growth under iron limitation conditions.
22. The immunogenic composition of claim 20-21 in which at least a part of the outer membrane vesicle preparation is derived from *Neisseria*.
- 25 23. The immunogenic composition of claims 20-22 in which at least a part of the outer membrane vesicle preparation is derived from *Neisseria meningitidis*.
24. The immunogenic composition of claims 20-23 in which at least a part of the outer membrane vesicle preparation is derived from *Neisseria meningitidis* serogroup B.
- 30 25. The immunogenic composition of claims 20-22 in which at least a part of the outer membrane vesicle preparation is derived from *Neisseria gonorrhoeae*.
- 35 26. The immunogenic composition of claims 20-25 wherein a host cell from which the outer membrane vesicle preparation is derived has been engineered so as to down-regulate the expression of one or more of LgtB and LgtE, preferably the former.
- 40 27. The immunogenic composition of claims 20-26 wherein a host cell from which the outer membrane vesicle preparation is derived is unable to synthesise capsular polysaccharides and has preferably been engineered so as to down-regulate the expression of and preferably to delete one or more of siaD, ctrA, ctrB, ctrC, ctrD, synA (equivalent to synX and siaA), synB (equivalent to siaB and synC (equivalent to siaC), most preferably siaD).
- 45 28. The immunogenic composition of claims 20-27 wherein a host cell from which the outer membrane vesicle preparation is derived has been engineered so as to

down-regulate the expression of and preferably delete one or more of OpC, OpA and PorA, preferably PorA.

5 29. The immunogenic composition of claims 20-28 wherein a host cell from which the outer membrane vesicle preparation is derived has been engineered so as to down-regulate the expression of and preferably delete FrpB.

10 30. The immunogenic composition of claims 20-29 wherein a host cell from which the outer membrane vesicle preparation is derived has been engineered so as to down-regulate the expression of and preferably delete msbB and/or HtrB, preferably msbB.

15 31. The immunogenic composition of claims 20-30 wherein the outer membrane vesicle preparation contains LPS which is conjugated to an outer membrane protein (OMP).

20 32. The immunogenic composition of claim 31 wherein LPS is conjugated (preferably intra-bleb) to OMP in situ in the outer membrane vesicle preparation.

25 33. The immunogenic composition of claims 20-32 in which at least a part of the outer membrane vesicle preparation is derived from *Moraxella catarrhalis*.

30 34. The immunogenic composition of claims 20-33 in which at least a part of the outer membrane vesicle preparation is derived from *Haemophilus influenzae*.

35 35. The immunogenic composition of claims 20-34 comprising an outer membrane vesicle preparation isolated from two or more strains of Gram negative bacteria.

40 36. The immunogenic composition of claim 35 in which transferrin binding protein and Hsf like protein are upregulated on different vesicles originating from different bacterial strains or on the same vesicles originating from the same bacterial strain.

45 37. The immunogenic preparation of claims 20-36 comprising an outer membrane vesicle preparation in which enhanced transferrin binding protein expression is derived from a polynucleic acid introduced into the Gram negative bacteria.

50 38. The immunogenic composition of claims 20-37 comprising an outer membrane vesicle preparation in which enhanced Hsf like protein expression is derived from a polynucleic acid introduced into the Gram negative bacteria.

45 39. The immunogenic composition of claims 20-38 comprising an outer membrane vesicle preparation in which enhanced transferrin binding protein and Hsf like protein expression is derived from a polynucleic acid encoding both proteins which was introduced into the Gram negative bacteria.

50 40. The immunogenic composition of claims 20-39 in which a bacterial strain has been genetically engineered so as to introduce a stronger promoter sequence upstream of a gene encoding transferrin binding protein.

41. The immunogenic composition of claims 20-40 in which a bacterial strain has been genetically engineered so as to introduce a stronger promoter sequence upstream of a gene encoding Hsf like protein.

5 42. The immunogenic composition of claims 20-41 in which a bacterial strain has been genetically engineered so as to introduce a stronger promoter sequence upstream of genes encoding transferrin binding protein and Hsf like protein.

10 43. The immunogenic composition of claims 20-42 in which the transferrin binding protein is TbpA which is preferably high molecular weight TbpA, low molecular weight TbpA or both high molecular weight TbpA and low molecular weight TbpA, most preferably from *N. meningitidis*.

15 44. The immunogenic composition of claims 20-43 in which the Hsf like protein is Hsf from *Neisseria meningitidis*.

45. The immunogenic composition of claims 1-44 further comprising plain or conjugated bacterial capsular polysaccharide or oligosaccharide.

20 46. The immunogenic composition of claim 1-45 comprising two or more bacterial capsular polysaccharides or oligosaccharides conjugated to transferrin binding protein or Hsf like proteins or both.

25 47. The immunogenic composition of claim 45-46 wherein the capsular polysaccharide or oligosaccharide is derived from one or more bacteria selected from the group consisting of *Neisseria meningitidis* serogroup A, *Neisseria meningitidis* serogroup C, *Neisseria meningitidis* serogroup Y, *Neisseria meningitidis* serogroup W-135, *Haemophilus influenzae* b, *Streptococcus pneumoniae*, Group A Streptococci, Group B Streptococci, *Staphylococcus aureus* and *Staphylococcus epidermidis*.

30 48. An immunogenic composition comprising one or more polynucleotide(s) encoding a transferrin binding protein or antigenic fragment thereof and a Hsf like protein or antigenic fragment thereof whose expression is driven by a eukaryotic promoter.

35 49. The immunogenic composition of claim 48 wherein TbpA and Hsf of *Neisseria* are encoded.

40 50. The immunogenic composition of claims 48-49 wherein TbpA and Hsf of *Neisseria meningitidis* are encoded.

45 51. The immunogenic composition of claims 1-50 comprising an adjuvant.

52. The immunogenic composition of claim 51 comprising aluminium salts.

53. The immunogenic composition of claim 51-52 comprising 3D-MPL.

54. The immunogenic composition of claim 51 comprising an adjuvant containing CpG.

5 55. A vaccine comprising the immunogenic composition of claims 1-54 and a pharmaceutically acceptable excipient.

10 56. A method for treatment or prevention of Gram negative bacterial disease comprising administering a protective dose or an effective amount of the vaccine of claim 55.

57. The method of claim 56 in which Neisserial infection is prevented or treated.

15 58. A use of the vaccine of claim 55 in the preparation of a medicament for treatment or prevention of Gram negative bacterial infection.

59. The use of claim 58 in the preparation of a medicament for treatment or prevention of Neisserial infection.

20 60. A genetically engineered Gram negative bacterial strain from which the outer membrane vesicles within the immunogenic composition of claims 20-44 can be derived.

25 61. A method of making the immunogenic composition of claims 1-17 comprising a step of mixing together isolated transferrin binding protein and isolated Hsf like protein or antigenic fragments thereof.

62. A method of making the immunogenic composition of claims 20-44 comprising a step of isolating outer membrane vesicles from a Gram negative bacterial culture.

30 63. The method of claim 62 wherein the step of isolating outer membrane vesicles involves extraction with 0-0.5%, 0.02-0.4%, 0.04-0.3%, 0.06-0.2%, 0.08-0.15% or preferably 0.1% detergent, preferably DOC.

35 64. A method of making the immunogenic composition of claim 47 comprising the step of conjugating bacterial capsular polysaccharides or oligosaccharides to transferrin binding protein and/or Hsf like protein.

40 65. A method of making the vaccine of claim 55 comprising a step of combining the immunogenic composition of claims 1-54 with a pharmaceutically acceptable excipient.

45 66. A method of preparing an immune globulin for use in prevention or treatment of Neisserial infection comprising the steps of immunising a recipient with the vaccine of claim 55 and isolating immune globulin from the recipient.

67. An immune globulin preparation obtainable from the method of claim 66.

50 68. A pharmaceutical preparation comprising the immune globulin preparation of claim 67 and a pharmaceutically acceptable excipient.

69. A pharmaceutical preparation comprising monoclonal antibodies against TbpA and Hsf of *Neisseria meningitidis* and a pharmaceutically acceptable excipient.

5 70. A method for treatment or prevention of Gram negative bacterial infection comprising a step of administering to the patient an effective amount of the pharmaceutical preparation of claims 68-69.

71. A use of the pharmaceutical preparation of claims 68-69 in the manufacture of a medicament for the treatment or prevention of Gram negative bacterial disease.